Illness associated with seafood

Fish and shellfish and their products are responsible for a substantial proportion of foodborne diseases worldwide. The proportion of outbreaks associated with seafood depends on local climate and dietary customs. Seafood is involved in an estimated 11% of foodborne outbreaks in the United States, 20% in Australia and over 70% in Japan, whose population has a greater tradition of eating raw seafood.[1] Seafood has a good reputation in Britain, where it is the vehicle of infection in only 2% of all reported foodborne outbreaks.[2] However, patterns of seafood consumption are changing: more fish is being eaten because of growing awareness of its nutritional benefits, and tastes are widening to include more raw fish and exotic species.

The main illnesses transmitted by fish and shellfish fall into three categories: allergies, infectious diseases and toxic syndromes. This review focuses on the infections and intoxications associated with seafood.

Infections

Bacterial diseases

Diseases caused by bacteria constitute a large proportion of illnesses associated with fish and shellfish.

Microorganisms in the natural marine environment: *Vibrio* species pose the most serious threat to human health.[3] These bacteria are native to warm coastal waters and estuaries and may also be found in inland fresh water. Of the 11 pathogenic *Vibrio* species 6 have been associated with seafood-transmitted illness: *V. cholerae*, *V. parahaemolyticus*, *V. vulnificus*, *V. mimicus*, *V. hollisae* and *V. furnissi*.[4]

Outbreaks of endemic cholera, caused by *V. cholerae* O1, continue to occur worldwide; in many, food is the vehicle of transmission. In 1974, mussels, clams and other partially cooked bivalves were implicated in an outbreak in Italy that involved 278 people, of whom 25 died.[5] All recent outbreaks in the United States have involved inadequately cooked or mishandled crustaceans such as crab and shrimp.[4] There are at least 80 non-O1 strains of *V. cholerae* widely distributed in the environment. Most of the strains isolated from seafood are incapable of producing the cholera toxin but can cause gastrointestinal illness. Two outbreaks have been associated with eating raw oysters.[4]

V. parahaemolyticus occurs in coastal waters worldwide and increases in numbers in the summer months. Most isolates obtained from seafood and marine environments are avirulent, but the proportion of isolates capable of producing gastroenteritis varies geographically.

V. vulnificus invades the intestinal tract, causing primary septicemia. This progressive disease has a death rate of about 50%.[4] *V. vulnificus* exists naturally in the Atlantic and Pacific oceans and the Gulf of Mexico. Sixty-two cases were reported in Florida between 1981 and 1987; many occurred after the consumption of raw oysters.[6]

Aeromonas hydrophila has been implicated in recent cases of gastroenteritis after the consumption of contaminated shellfish. In 1986, 472 cases of gastroenteritis were associated with frozen raw oysters that had been stored at −72°C for 18 months; this highlights the survival properties of *A. hydrophila* under extreme conditions.[7]

Plesiomonas shigelloides has been the cause of several recently reported cases of gastroenteritis in

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different parts of the world.[8] Common food vehicles for this organism have been raw oysters, mussels, salt mackerel and cuttlefish.

The link between seafood and *Clostridium botulinum* became well established in areas such as Japan and Alaska, where fish is traditionally eaten raw or lightly cooked. Botulism outbreaks in North America and Britain have mainly involved preserved products. Of the eight existing types of *C. botulinum*, type E is most frequently isolated from aquatic environments.[4]

Bacteria in polluted marine environments: Species such as *Salmonella* and *Shigella* pass into rivers, lakes and coastal waters via the discharge of untreated sewage, the accumulation of agricultural wastes and land runoff after rain. Many enteric pathogens survive sewage processing and are able to contaminate seafood.

Shellfish are harvested mostly from coastal or estuarine waters. Bivalve molluscs (e.g., oysters, mussels, clams and cockles) feed by sieving large volumes of water and retaining food particles; thus contaminants are concentrated. Oysters are generally eaten raw, and other bivalves are often lightly cooked. The infectious dose of enteric bacteria tends to be high, but the concentrating effect of bivalve filter feeding and mishandling after catching can produce high levels of contamination in shellfish.

Contamination after harvesting: The bacterial species involved in this type of contamination are derived from equipment, utensils and premises used for processing and from food handlers. *Staphylococcus aureus* causes the bulk of fish-associated outbreaks by this means. Outbreaks due to bacteria such as *Bacillus cereus* and *C. perfringens* that form part of the normal fish-gut flora have also occurred. Food contamination problems then arise because of undercooking and poor temperature control in storage facilities.

Listeria species have been discovered in frozen seafood products such as shrimp and crab and in fresh seafood and coastal waters,[9] although no outbreaks have been linked directly to seafood so far.

Viral diseases

Viruses enter the marine environment through the direct discharge of domestic sewage and the dumping of sewage sludge into the ocean. Enteric viruses show greater resistance to sewage treatment processes than enteric bacteria and remain viable in seawater for many weeks or months (the hepatitis A virus can survive for over a year[10]). A British study attributed 25% of hepatitis A outbreaks that occurred before 1983 to shellfish consumption.[11]

Small, round viruses of the Norwalk group are the commonest cause of viral gastroenteritis associated with shellfish.[12] The main symptoms are nausea, vomiting, diarrhea and abdominal cramps, which develop 24 to 48 hours after ingestion and last from 1 to 2 days.

Parasitic diseases

Trematode and cestode (fluke and tapeworm) infections are common only where it is customary to consume raw or undercooked fish (e.g., Japan, Saudi Arabia and southeast Asia).[13]

The main source of parasitic infection from the marine environment is the nematode *Anisakis*.[14] Anisakiasis is commonly associated with marine salmon and herring and results from the burrowing of larvae into the gastrointestinal tract of the host.

Intoxications

Four groups of toxin exist: those of algal origin that become more concentrated as they pass through the food chain (shellfish toxins, ciguatoxins), toxins resulting from bacterial spoilage (scombrotoxin and possibly tetrodotoxin), naturally occurring toxins (tetramine) and chemical contaminants present in polluted marine environments.

Paralytic shellfish poisoning (PSP)

PSP is caused by eating shellfish contaminated with marine dinoflagellates that occur at latitudes greater than 30° north or south, where ambient temperatures are about 15°C to 17°C. Three algal species are linked to PSP: *Gonyaulax catenella*, which is found along the Pacific coast of North America and in Japan; *G. tamarensis*, which has been associated with outbreaks on the east coast of North America and the coast of mainland Europe; and *Pyrodinium bahamense*, which since the early 1970s has been linked to PSP outbreaks in South America and southeast Asia.

All British incidents have involved mussels; 10 outbreaks of PSP were identified between 1827 and 1975,[15] involving 116 cases and 14 deaths.

PSP is characterized by numbness in the mouth and fingertips, followed by impaired muscle coordination. Respiratory distress and paralysis can occur in severe cases and occasionally lead to death.

Neurotoxic shellfish poisoning

The toxins responsible for neurotoxic shellfish poisoning are produced by the dinoflagellate *Ptychodiscus brevis*.[16] Outbreaks have occurred mainly in North America and are associated with the consumption of oysters, clams and other bivalve molluscs.

Amnesic shellfish poisoning

Amnesic shellfish poisoning was first described in Canada, when 107 people in 1987 became ill and 3 died after eating cultivated blue mussels.[17] The symptoms include vomiting, diarrhea, abdominal cramps, headache and loss of short-term memory; the last symptom may be permanent in some cases. The causative agent was identified as domoic acid originating from the marine diatom *Nitzschia pungens,* which is widely distributed in coastal waters of the Atlantic, Pacific and Indian oceans. Domoic acid is acutely neurotoxic for the mammalian central nervous system.

Diarrhetic shellfish poisoning

Diarrhetic shellfish poisoning has been a severe public health problem in Japan for many years (1300 cases were recorded between 1976 and 1982), and it now has a worldwide distribution because of the shifting population patterns of the algae *Dinophysis* and *Prorocentrum.*[18] Outbreaks have also occurred in the Netherlands, France and Italy.

The main toxic components are okadaic acid and *Dinophysis* toxins 1 to 3, originally characterized from material obtained from the blue mussel. Shellfish acting as vehicles for the disease include mussels, scallops and clams. The most common symptoms are diarrhea, nausea, vomiting and abdominal pain, which can persist for up to 3 days.

Ciguatera

Ciguatera is the largest global public health problem associated with seafood. The worldwide incidence rate has been estimated to be 50 000 cases per year.[19] The Pacific, Caribbean and Indian oceans are the main danger areas. The principal fish involved are grouper, snapper, barracuda, jack, surgeonfish and sea bass.

The symptoms vary widely, because several toxins are involved and the response is dose-dependent. The clinical features include nausea, vomiting, abdominal pain, dizziness, blurred vision, reversal of the sensations of heat and cold, blindness (which may be temporary), paralysis and death. The death rate is 7% to 20%. Onset is usually within a few hours after the consumption of contaminated fish, and the neurologic effects can persist for several months. As yet there is no antidote to ciguatoxin.

The origins of ciguatera were unknown until 1977, when the marine dinoflagellate *Gambierdiscus toxicus* was implicated as the causative alga. Subsequently two other algae, *Prorocentrum concavum* and *P. mexicanum*, were shown to produce similar neurotoxins.

These heat-stable toxins are unaffected by cooking and processing methods, and contaminated fish appear normal. The only advice for consumers is to avoid large fish of the hazardous species, in which the effects of toxin concentration up the food chain are greatest.

Scombroid fish poisoning

Scombroid fish poisoning is now recognized throughout the world. Most incidents have been recorded in the United States, Japan and Britain, although many cases are unrecorded because of the comparative mildness of symptoms and the nonreporting of foodborne illnesses in many countries. Of 438 suspected incidents in Britain between 1976 and 1990,[20] 167 have been confirmed through histamine analysis. The name of the disease is derived from its close association with fish of the *Scombridae* and *Scomberesocidae* families (tuna, mackerel and bonito), although other fish have been implicated. The disease is characterized by rapid onset (typically 10 minutes to 2 hours after ingestion); symptoms include a rash on the neck and face, flushing, sweating, headache, nausea, vomiting, diarrhea, a burning sensation in the mouth and abdominal cramps. These usually resolve within a few hours.

Scombroid fish poisoning is often misdiagnosed as a food allergy. It results from eating fish that contain high levels of histamine produced through decarboxylation of the amino acid histidine, which is abundant in scombroid fish flesh. Histamine is heat stable and will withstand canning procedures; therefore, fish should be stored at low temperatures immediately after catching and during processing, and hygienic food-handling practices should be used throughout preparation.

Puffer-fish poisoning

Incidents of puffer-fish poisoning are rare outside Japan, where over 6000 cases have been recorded in the last 78 years.[21] The causative toxin is tetrodotoxin (and its derivative anhydrotetrodotoxin), a heat-stable, nonprotein neurotoxin concentrated in the skin and viscera of puffer fish, porcupine fish, ocean sunfish, and species of newts and salamanders. No cases have as yet been recorded in Britain. The disease has a death rate approaching 60%. The onset of poisoning is usually within 3 hours after ingestion, and symptoms may last for 3 days if the patient survives the first 24 hours.

Red whelk poisoning

Since 1970 six incidents of poisoning from

eating red whelk (*Neptunea antiqua*) have been recorded in Britain. The red whelk contains the metabolite tetramine in its salivary gland. This curare-like compound produces blurred vision, muscular twitching, weakness, paralysis and collapse. The symptoms usually resolve within 24 hours.

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Conferences

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May 30-June 3, 1993: 17th Congress of the International Association for Suicide Prevention (combined meeting with the Canadian Association for Suicide Prevention and l'Association québécoise de suicidologie organized in collaboration with Suicide-Action Montréal)
Judith-Jasmin Pavilion, University of Quebec at Montreal
Official languages: English and French
I.A.S.P. Congress, c/o Professor Brian L. Mishara, LAREHS, University of Quebec at Montreal, PO Box 8888, Stn. A, Montreal, PQ H3C 3P8; (514) 987-4832, fax (514) 987-8408

Du 30 mai au 3 juin 1993: XVII[e] Congrès de l'Association internationale pour la prévention du suicide (Congrès conjoint de l'Association canadienne pour la prévention du suicide et de l'Association québécoise de suicidologie organisé avec la collaboration de Suicide-Action Montréal)
Pavillon Judith-Jasmin, Université du Québec à Montréal
Les langues officielles: le français et l'anglais
Congrès I.A.S.P., a/s Professeur Brian L. Mishara, LAREHS, Université du Québec à Montréal, CP 8888, Succ. A, Montréal, QC H3C 3P8; (514) 987-4832, fax (514) 987-8408

June 27-July 1, 1993: 3rd International Conference on Preventive Cardiology (organized by the International Society and Federation of Cardiology and its Council on Epidemiology and Prevention)
Oslo
All conference areas will be smoke-free.
Conference Secretariat, 3rd International Conference on Preventive Cardiology, Statens helseundersokelser (SHUS), PO Box 8155, Dep. N-0033, Oslo, Norway; telephone 011-472-20-76-55, fax 011-472-20-16-73

Aug. 23-27, 1993: 3rd International Congress on Amino Acids and Analogues
Hotel Capsis Beach and Bungalows, Aghia Pelaghia, Crete
Dr. G. Lubec, Department of Paediatrics, University of Vienna, Währinger Gürtel 18, A 1090 Vienna, Austria; fax 011-43-1-40400-3238

Sept. 7-10, 1993: 6th International Congress on Interventional Ultrasound
Copenhagen
Christian Nolsoe, Congress Secretary, Department of Ultrasound, Herlev Hospital, University of Copenhagen, DK-2730 Herlev, Denmark